

NATIONAL BUREAU OF STANDARDS REPORT

5981

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report for the Period April 1 to June 30, 1958

By
Photometry and Colorimetry Section
Optics and Metrology Division



U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government Agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

Reports and Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: The Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards (\$1.25) and its Supplement (\$0.75), available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Inquiries regarding the Bureau's reports should be addressed to the Office of Technical Information, National Bureau of Standards, Washington 25, D. C.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT

NBS REPORT

0201-20-2301
0201-20-2327

July 1958

5981

Development, Testing, and Evaluation of Visual Landing Aids

Consolidated Progress Report
to
Ship Installations Division
Bureau of Aeronautics
Department of the Navy
Washington 25, D.C.

For the Period
April 1 to June 30, 1958

For
Bureau of Aeronautics Projects
TED No. NBS-AE-10002
TED No. NBS-AE-10011

IMPORTANT NOTICE

NATIONAL BUREAU OF STANDARDS
Intended for use within the Government
to additional evaluation and re-
listing of this Report, either in
the Office of the Director, National
Bureau of Standards, or, however, by the Government
to reproduce additional copies

Approved for public release by the
director of the National Institute of
Standards and Technology (NIST)
on October 9, 2015

Progress accounting documents
formally published it is subjected
reproduction, or open-literature
permission is obtained in writing from
Such permission is not needed,
prepared if that agency wishes



U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Development, Testing, and Evaluation of
Visual Landing Aids
April 1 to June 30, 1958

1. REPORTS ISSUED

Report No.	Title
5889	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period January 1 to March 31, 1958.
5893	Report of a Survey of Visual Landing Aids.
21P-3/58	Photometric and Life Tests of Eight 500-Watt, 20-Ampere PAR-56 Approach-Light Lamps.
21P-13/58	Photometric Tests of One Fueling-Lane Light.
21P-16/58	Fading of Colors to be Used for the Background of Runway Distance Markers.
21P-18/58	Photometric Tests of a Modified Fueling-Lane Light.

II. RESEARCH AND DEVELOPMENT, LABORATORY TESTING, AND CONSULTATION SERVICES IN CONNECTION WITH VISIBILITY, AIRFIELD LIGHTING, AND FOG MODIFICATION PROBLEMS (TED NBS-AE-10002).

a. Visibility Meters and Their Application.

Transmissometer Receiver. Service tests of type WL-759 tubes made with a revised processing procedure have continued. These new tubes have operated satisfactorily and have exhibited none of the faults of the tubes from previous lots. As the tubes now being manufactured are satisfactory, tests of these tubes will be discontinued.

A study is being made of circuit modifications which will substantially increase the pulse rate of the receiver. (See NBS Report 5767.) The receiver of the transmissometer installed at the National Bureau of Standards has been modified by connecting a 0.5-megohm resistor and a 0.005-microfarad capacitor in parallel between the cathode of the trigger tube and ground. This modification has produced a fourfold increase in the pulse rate. The instrument has operated for several weeks with no adverse effects on the trigger tube. The modification has, however, made the response of the pulse-amplifier somewhat nonlinear. Efforts are now being made to correct this.

Indicator Sensitivity. Following reports from the Weather Bureau that the gain of the amplifier of recent transmissometer indicators was insufficient when the signal line had an unusually high resistance, a check was made of the amplifier gain of indicators of several lots. There has been a progressive decrease in amplifier gain because of the cumulative effect of small changes in circuitry. The gain of the amplifier can be increased so that it will be greater than that of the original NBS amplifiers by the following circuit changes.

Change V204 from a type 6SJ7 to a type 6AC7 tube.

Change R223 from a 10,000-ohm resistor to a 5,000-ohm resistor.

These changes will not affect the 60-cycle filtering action of the amplifier as would increasing the capacitance of C206. They will, however, cause a small reduction in the signal-to-noise ratio.

Phototubes for Slant-Visibility Meters and Ceilometers. A service test quantity of special phototubes designed to improve the performance of the slant-visibility meter being tested at Arcata and of fixed-beam ceilometers has been received from the Continental Electric Company. The sensitivity of these tubes is higher and the dark current is lower for these tubes than for the type 929 and 1P39 phototubes. The anode of the new tubes is constructed so that it does not cast a shadow on the cathode and is fixed in position with respect to the cathode. Hence, noise resulting from modulation of the background light by movement of the anode should be significantly reduced. These tubes are now being tested in the slant-visibility meter at Arcata and in a Weather Bureau installation at New York.

b. Airfield Lighting and Marking.

Fueling-Lane Lights. A report giving the results of intensity distribution measurements of an experimental refueling-lane light made by the L. C. Doane Company has been released. This light uses a 200-watt, 6.6-ampere PAR46 lamp with a rated life of 500 hours. The intensity of the light is several times that of the fueling-lane lights now being used. The peak intensity of the new light is 5,300 candles; that of the old, 1,100 candles with lamps having a rated life of 50 hours. Beam spreads are comparable. (NBS Test 21P-13/58)

Intensity distribution and temperature rise measurements have also been made and reported of a light of the type now being used, but modified by the substitution of 100-watt, 6.5-volt lamps for the present 50-watt lamps, and the replacement of the window and reflector assembly with new components supplied by the manufacturer. The lamps were operated at a voltage which would result in a lamp life of 500 hours. The peak intensity of this light was 3,200 candles and the beam spread was comparable with that of the unmodified light. The temperature rise of the present transformer is higher than desirable when 100-watt lamps are used. (NBS Test 21P-18/58)

Runway Distance-Marker Paints. A report giving the results of a study of the fading of fluorescent orange paint intended for use on the background of runway distance markers has been released. Panels were exposed at four Air Stations and tested at intervals of three months. The effectiveness of the fluorescent paints appears to have remained satisfactory for the first six months. Deterioration was rapid thereafter, particularly for samples exposed at Miramar. (NBS Test 21P-16/58)

Coated Aluminum Reflectors. Several samples of coated aluminum reflectors, manufactured by Kingston Industries Corporation, were tested for reflectance characteristics and for hardness. A report of the results of these tests has been prepared during this quarter.

c. Seadrome Lighting.

Battery-Operated Seadrome Lights. The circuit of the photo-electric ON-OFF control has been revised to adapt it to operate a light using a 12-volt battery and a vibrator. The circuitry has been modified so that the control will not be overloaded during daylight. (See figure 1.) This is accomplished by connecting the OFF photocells in series with the ON cells when the circuit is in the OFF position. The number of cells and their fields of view are such that under all daylight conditions the current generated by the OFF cells is greater than the current generated by the ON cells. This drives the transistor V_1 toward cutoff and the ON relay (K_1) remains unenergized. At night the current generated by both sets of photocells is very low. When the control is illuminated by aviation green light, the current generated by the OFF cells is not increased significantly while the current generated by the ON cells is increased. This increases the current through transistor V_1 energizing relay K_1 and turning on the light. When the circuit is in the ON position, illuminating the control with red or white light increases the current of the OFF cells, which through transistor V_3 energizes relay K_2 and turns off the light.

Channel Identification Lights. Two inspection trips have been made to NAS Norfolk to determine the cause of failures in the gear-reducer motors of these lights. The trouble appears to be excessive wear in the worm gear on the output shaft resulting from the drag of the slip rings and the high speed of the motor. The motor drive will be redesigned to overcome this difficulty.

Tests on Insulating Base for Medium Bipost Lamp Socket in Sealane Marker Light. Following reports from NATC of severe leakage at the socket of cable-fed sealane lights, a series circuit was assembled for operating a sealane marker light with the lens and filter removed. Provisions were made for measuring the current being delivered to the socket leads and to the lamp. The difference between the readings represents the leakage current across the insulating base and between the conductors in the socket leads.

Bases were machined from Teflon, Micarta, and Micallex to the same dimensions as the Transite base furnished with the unit. The unit was operated with each of the four bases under test conditions as listed in table I in the order shown. The lamp and socket currents were recorded and the current differences listed.

The results of the first 8 tests indicated that there was no justification for using one of the more expensive materials in preference to the Transite in current use. A second Transite base was made and then treated with a silicone-base grease. By this time the socket leads had been repeatedly soaked in a saturated salt solution, and as a result there developed a leakage current between the two leads of the order of 1 ampere. The current differences shown in the table for the silicone-treated base include this leakage current. Since the leakage varied over a moderate range, depending upon the relative position of the leads, no definite value can be assigned it, but it is of the order of 1 ampere. The results of the tests indicate that a silicone-treated Transite base would be preferred over any of the other materials tested.

Table I

Leakage Currents in Sealane Marker Light

Test No.	Socket Material → Test Condition	Teflon	Transite	Micarta	Micallex	Silicone Treated Transite
		ΔI (Amps)	ΔI (Amps)	ΔI (Amps)	ΔI (Amps)	ΔI (Amps)
1	Dry.	0.00	0.00	0.00	0.00	
2	Soaked 16 hrs. in tap water, then blotted.	0.00	0.00	0.00	0.00	
3	Tested while submerged in tap water.	0.08	0.08	0.08	0.08	
4	Soaked 67 hrs. in 3% NaCl solution, then blotted.	0.00	0.00	0.00	0.00	
5	Tested while submerged in 3% NaCl solution,	8.92	9.24	9.04	9.24	
6	Soaked 16 hrs. in saturated NaCl solution, then blotted.	0.00	0.12	0.04	0.04	
7	Tested while submerged in saturated NaCl solution.	14.28	14.24	14.08	13.88	
8	Tested immediately after pulling from saturated NaCl solution.	0.08	0.32	0.16	0.40	
9	Same as Test 7.					12.00*
10	Same as Test 8.					0.96*

*Before testing the silicone-treated Transite, the leads to the lamp had been repeatedly submerged in saturated salt solution. As a result, the insulation became saturated and there was a leakage current between the conductors of the order of 1 ampere. These two ΔI 's include that leakage current.

Approach-Light Lamps. Life tests of 500-watt, 20-ampere, PAR-56 approach-light lamps have been completed and a report giving the results of these tests and photometric tests has been issued. These tests show that because of the blackening of the reflector and the lens the useful life of these lamps is much less than their operating life. Hence, allowing these lamps to operate until burnout will be unsatisfactory and a replacement procedure which will insure lamp replacement at the end of the useful life should be established. (NBS Test 21P-3/58)

d. Carrier Lighting and Marking.

No work was done on this task during the quarter:

e. Lights for Carrier-Deck Personnel.

Several conferences have been held with representatives of the Visual Landing Aids Branch and the Naval Air Engineering Facility at which the various types of prototype equipment developed by the National Bureau of Standards were demonstrated. As a result of these conferences the following decisions were made.

1. Standard C-size flashlight cases will be used instead of modified cases with a connector at the rear of the case. If rechargeable batteries are used, they will be charged outside the light in a specially designed light.

2. A recently developed wand made of polyethylene will be used instead of the present etched acrylic cone. The polyethylene material has a waxy white translucent appearance and does not require etching as do the acrylic wands. It remains flexible over a wide range of temperatures, thus eliminating breakage. This wand is a substantial improvement over the acrylic wands and a major improvement over the wands now in service.

3. Prototypes of two types of "eyeball" or goggle lights will be constructed. One will be a self-contained unit including a small nickel-cadmium battery and a switch mounted on the goggles. The other will have the battery mounted in the helmet or headgear.

f. General.

U. S. Standard for Signal Light Colors. In accordance with the action taken at the last meeting of the U. S. National Committee on Signal Light Colors, four subcommittees have been appointed to work out the details for the adoption of the U. S. Standard by the authoritative agencies for aeronautical, highway, marine, and railroad signal lights. Arrangements are being made to assist these subcommittees with demonstrations of the effect of substituting proposed limits for those now in use.

Handbook on Signal Light Colors. On June 30th approximately 85% of the text for the handbook, which will probably appear as an NBS circular, had been written. About 45% of the text had been edited and typed for Division review. The present draft calls for about 35 figures. About half of these are available, although some of these will require revision.

III. VISIBILITY AND BRIGHTNESS TESTS, SURVEYS, EVALUATION AND ANALYSIS OF VISUAL LANDING AIDS, BASIC TESTS AND EQUIPMENT, AS A FIELD SERVICE AT ARCATA, CALIFORNIA (TED NBS-AE-10011).

a. Airfield Lighting and Marking.

Approach Beacons. Two approach beacons have been assembled and shipped to the El Toro Marine Corps Air Station for use in operational tests of the approach-beacon system. A brief description of the system, giving installation and operational details, has been prepared for interim use at El Toro and elsewhere pending completion of the final report of this task. The first draft of this final report has been completed.

b. Electrical Engineering.

Visual Landing Aids Survey. The results of this survey have been reported in NBS Report 5893. The survey showed that many maintenance problems at the West Coast stations were similar to those reported previously. Visual landing aids are not being utilized operationally to the fullest extent because of lack of pilot training. The more important requirements for better use and maintenance of visual landing aids are as follows: better standardization of lighting and marking systems at all fields; a comprehensive pilot training program in the use of all visual landing aids; more stringent requirements for contract installations; assignment of responsibility for maintenance to one man who has been given special training; and the provision to maintenance personnel of the needed equipment, particularly suitable vehicles and communications equipment, special tools, and technical and maintenance information.

The report includes an appendix giving many of the pertinent and interesting comments of pilots and operational personnel regarding the use of visual landing aids. A supplement to this report is being prepared giving a tabulation of numerical data obtained during the survey.

Airfield Lighting Maintenance Manual. With the completion of the survey report, work has been started on the section of the maintenance manual covering routine and preventive maintenance.

Cable-Fault Finding. Tests have been made of the performance of the TSM-11 Test Set at Rohnerville and Arcata Airports. At Rohnerville a simple fault, an isolating transformer, was located without incident. There was, however, a false signal in a water pipe line which ran within 12 inches of the fault. The signal entered the pipe line at this point with about half of the signal returning to the vicinity of the signal generator via this pipe and half through earth. Thus a misleading indication of the location of the lighting circuit was obtained. This indicates that in using the TSM-11 attention should be given to the drawings indicating location of the wires on the field. At Arcata Airport the TSM-11 was used on a runway-lighting circuit using type AN-L-9 lights. Many of the lights were filled with water, but there were no indications of grounds obtained from a visual inspection of the lights. A study of the performance of the Test Set with this circuit indicates that in areas of high ground resistance exceptional care must be used in locating grounds, especially if there are several grounds in the circuit and the detection of opens will be very difficult. If the instrument is to be used to determine the depth a cable is buried, the signal strength must be such that the indicator operates in the linear part of the range.

c. Research in Visibility and Visibility Measurements.

Effective Intensity of Flashing Lights. The analysis of the data obtained in this study has been completed. Drafting and editing of the report covering the work have been completed. The report will be issued early next quarter.

Slant Visibility Meter. The projector power wiring was changed in order to make the unit more convenient and safe to operate by modifying the interlock circuits so that both sides of the input to the lamp circuit are opened, thus eliminating the possibility of high voltage at the lamp should there be a ground in the transformers in this circuit. A switch was added to the compressor output to remove power from the lamp should the pressure drop below 10 psi.

In order to determine the feasibility of using an instrument of this type as a shipboard visibility meter, studies are being made of the stability of the output of the projector and of the sensitivity and indicator units. The output of the projector is being monitored continuously by auxiliary photometric equipment. Tests are being made with the new shadowless-anode phototubes. Results to date are satisfactory. The calibrator has been modified so that a tenfold increase in its output signal can be obtained.

Transmissometers. Some data have been gathered on the errors introduced by scattered light from the projector, using a blue-sensitive (S-4 surface) photocell in the receiver. The data obtained to date are not sufficient to indicate whether the error is of the same order of magnitude as it was with the red-sensitive photocell. A receiver has been adapted to permit the measurement of the scattered-light error as a function of the field of view of the receiver.

Tests are being made of the performance of premium-type voltage-regulator tubes (types 6073 and 6074) in the indicator in place of the type OC3 and OD3 tubes to determine if the stability of the indicators will be sufficiently improved to warrant the use of these tubes.

Brightness and Illumination Measurements. The installation of instruments, signal lines, and remote-indicating equipment is now complete. Simultaneous measurements of horizontal and vertical illumination and horizon sky brightness are being made at two locations about 5000 feet apart to determine the need for making measurements of this type in the approach or touchdown area. The data will also be used in determining the effects of these parameters on visual range. Some problems in calibration of the instruments have been encountered and are being studied.

d. Facilities.

A small tornado passed through the approach zone of runway 31 on March 29, causing minor damage to equipment. This damage has been repaired.

July 1958

US COMM-NBS-DC

U. S. DEPARTMENT OF COMMERCE

Sinclair Weeks, *Secretary*

NATIONAL BUREAU OF STANDARDS

A. V. Astin, *Director*



THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its headquarters in Washington, D. C., and its major laboratories in Boulder, Colo., is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside front cover.

WASHINGTON, D. C.

Electricity and Electronics. Resistance and Reactance. Electron Devices. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Engine Fuels. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Nuclear Physics. Radioactivity. X-rays. Betatron. Nucleonic Instrumentation. Radiological Equipment.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Mechanical Instruments. Fluid Mechanics. Engineering Mechanics. Mass and Scale. Capacity, Density, and Fluid Meters. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Concreting Materials. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Air Conditioning, Heating, and Refrigeration. Floor, Roof, and Wall Coverings. Codes and Safety Standards. Heat Transfer.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

Data Processing Systems. SEAC Engineering Group. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Application Engineering.

• Office of Basic Instrumentation.

• Office of Weights and Measures.

BOULDER, COLORADO

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

Radio Propagation Physics. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Sun-Earth Relationships. VHF Research.

Radio Propagation Engineering. Data Reduction Instrumentation. Modulation Systems. Navigation Systems. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Radio Systems Application Engineering. Radio Meteorology.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Calibration Center. Microwave Physics. Microwave Circuit Standards.

